



**US Army Corps  
of Engineers®**

Engineer Research and  
Development Center

# RTK GPS Water Navigation

## Objective

Provide a navigation system that displays the vertical distance between a vessel's keel and the project depth. The project depth is the Congressional Authorization Depth below Mean Lower Low Water (MLLW) in the United States. Another objective is to create a useful pilot instrument.

## Background

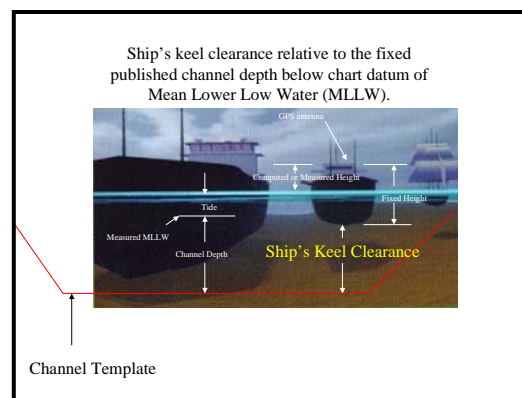
The Real Time Kinematic (RTK) GPS Water Levels concept was developed at ERDC Alexandria, Virginia in 1993 and first field-tested in the Saint Mary's Entrance Channel, U.S. Army Engineer District, Jacksonville in July 1998. To date, the system has never been used yet for under keel clearance here or anywhere else; however, the system is mandatory for use during dredging operations in the entrance channel. Three other USACE Districts use the system the same way. The GPS Water Levels technique can also be used as a navigation tool for deep draft vessels because the project depth is dredged relative to the MLLW chart datum. The same infrastructure used for GPS Water Levels can be used for RTK GPS Water Navigation.

## Description

This system uses a land-based GPS reference station operating in a carrier differential mode of operation. Radio signals (radios, cell phones) transmit carrier differential information to ships in the approach channels enabling properly equipped GPS receivers onboard the vessel to produce centimeter-level three-dimensional positions every second. This position information is coupled with the ship's keel distance below the GPS receiver to determine the keel height above a predefined grid of the navigation channel and specifically the project depth or the bottom of the navigation channel. The bottom of the navigation channel should be slightly above the actual bathymetry. If it's not, a shoal has formed in the navigation channel and dredging is required to remove the shoal. Shoals can be detected remotely by correlation of RTK GPS and the existing acoustic transducer information used by deep draft vessels.

## Benefit

The RTK GPS Water Navigation method allows ships to load more precisely with respect to the bottom of the navigation channel. Today, ships know depths below the keel to the ever-changing bathymetry, but the information is not relative to a fixed vertical datum. With this new method, deep draft vessels can carry more cargo and monitor their keel more safely than before. The Europeans already have started testing the RTK GPS for this purpose in Rotterdam. The under keel clearance system will benefit ports up to \$30 million per year by loading vessels deeper and safer.



As an aid to protect pilots, the system can refute accusations of pilot error by providing the vessel track, shoal locations, speed, and draft of a vessel as it transits a waterway. The system may also be used to document pilot error by showing high vessel speeds leading to settlement and grounding in a properly maintained navigation channel.

**Point of Contact**

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